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Water-Resources Investigations In Texas

Fiscal Year 1972

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Texas District

UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Water Resources Division

Texas District

WATER RESOURCES INVESTIGATIONS IN TEXAS FISCAL YEAR 1972

Austin, Texas

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WATER-RESOURCES INVESTIGATIONS IN TEXAS

FISCAL YEAR 1972

INTRODUCTION

The program of the Water Resources Division in Texas consists of the collection of basic records through the hydrologic-data network, interpretive studies, and research projects. The basic-data records and the results of investigations are published by the Geological Survey or by cooperating agencies. This report describes the projects and activities of the Water Resources Division in Texas for the 1972 fiscal year (July 1, 1971, to June 30, 1972).

The Geological Survey's investigations of the water resources of Texas are under the general direction of I. D. Yost, District Chief. The Texas District office is in the Federal Building, 300 East 8th Street, Austin, Texas 78701.

Copies of published records, copies of basic data prior to publication, and other unpublished records may be obtained from the District Office by request.

Information regarding provisional records of stream discharge prior to publication and other hydrologic data collected within their respective areas may be obtained from the Subdistrict offices in Fort Worth, Houston, San Angelo, San Antonio, and Wichita Falls or the Austin Field Unit in Austin. Requests for information should be addressed as follows:

I. D. Yost, District Chief
U.S. Geological Survey
Federal Building
300 East 8th Street
Austin, Texas 78701

James W. Board, Engineer-in-Charge
Austin Field Unit
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Fort Worth, Texas 76115

Ernest S. Denison, Subdistrict Chief
U.S. Geological Survey
1409 Knickerbocker Road
San Angelo, Texas 76901

A. E. Hulme, Subdistrict Chief
U.S. Geological Survey
Room 116, 7077 San Pedro
San Antonio, Texas 78216

J. O. Joerns, Subdistrict Chief
U.S. Geological Survey
318-320A Federal Building
Wichita Falls, Texas 76301

COLLECTION OF BASIC RECORDS

A significant activity in the Texas District is the collection of basic hydrologic data. A continuing series of measurements are made of streamflow, reservoir contents, chemical quality of water, sediment in streams and reservoirs, water levels in wells, and land-surface subsidence.

Modern computer techniques are being used successfully in the collection and publication of water data. By the end of the 1972 fiscal year, the following installations will be in operation: Approximately 232 digital recorders at stream-gaging stations; 24 conductivity recorders; and one instrument for continuously and simultaneously monitoring and recording the water-quality characteristics of conductivity, water temperature, dissolved oxygen, and pH. The use of electronic data processing for printing and storing water records will be expanded.

Surface-Water Records

Continuous-Record Streamflow Stations

As of June 30, 1971, 573 stream-gaging, stage-only, and reservoir-contents stations were in operation. During the 1972 fiscal year, nine stations will be established, and three stations will be discontinued.

Partial-Record Streamflow Stations

Low-flow partial-record stations.--As of June 30, 1971, 127 low-flow partial-record stations were in operation. During the 1972 fiscal year, five stations are scheduled to be established (not listed in summary of scheduled changes in station-network table).

Crest-stage partial-record stations.--As of June 30, 1971, 191 crest-stage partial-record stations were in operation. Of these, 40 were operated in the urban hydrology study areas in Dallas, Houston, and San Antonio. One additional station is scheduled to be established during the 1972 fiscal year (not listed in summary of scheduled changes in station-network table).

Tide-level stations.--As of June 30, 1971, 28 tide-level stations were in operation. During the 1972 fiscal year, six stations will be established and one station will be relocated.

Continuous Water-Quality Stations

As of June 30, 1971, one multi-parameter water-quality monitor and 24 conductivity recorders were in operation. No additional conductivity recorders will be established during the 1972 fiscal year. The water-quality monitor is located on the Sabine River and the conductivity recorders are located at stations in the Hubbard Creek, Red, Neches, Brazos, Colorado, and Guadalupe River Basins.

Daily Water-Quality Stations

Daily chemical-quality stations.--As of June 30, 1971, 110 daily chemical-quality stations were in operation. Sufficient samples are collected at these stations to define the total daily chemical loads. During the 1972 fiscal year, no new stations will be established.

Daily suspended-sediment stations.--As of June 30, 1971, nine daily suspended-sediment stations were in operation. No stations are to be established or discontinued during the 1972 fiscal year.

Partial-Record Water-Quality Stations

A partial-record water-quality station is a site where limited water-quality data are collected systematically over a period of years for use in correlative analyses.

Partial-record chemical-quality stations.--As of June 30, 1971, the partial-record chemical-quality network consisted of stations at 151 sites on streams and stations at sites on 53 reservoirs. During the 1972 fiscal year, no new stations will be added to the network.

Special periodic water-quality sampling sites.--Special periodic sampling will be done during the 1972 fiscal year at 149 stations. The analyses will include determinations of standard chemical-quality, BOD (biochemical-oxygen demand), DO (dissolved oxygen), NO_3 (nitrate), PO_4 (phosphate), pH, pesticides in unfiltered water samples and bottom deposits, and minor elements.

Periodic suspended-sediment stations.--The periodic suspended-sediment station network was established in 1966, and as of June 30, 1971, 33 stations were in operation. No expansion of this network is anticipated during the 1972 fiscal year.

Reservoir Studies

The fiscal 1972 program provides for three water-quality surveys of each of six reservoirs: Livingston; Hubbard Creek; Possum Kingdom; Granbury; Whitney; and Belton and two surveys of Sam Rayburn Lake. On-site determinations will be made of specific conductance, dissolved oxygen, temperature, and pH. Samples will be collected during each survey for laboratory analyses.

Summary of Scheduled Changes in Data Stations

Type of record: C--crest-stage partial-record; D--streamflow; G--stage only; L--low-flow partial-record; P--range-in-stage partial-record; Q--daily chemical-quality; Qc--continuous-record chemical-quality; Qd--periodic chemical-quality; Qn--periodic nutrient determinations; Qp--periodic pesticides determinations; R--reservoir-content.

Name of station	Type of record	Cooperation with USGS	Purpose of station and remarks
		New Stations to be Established	
07312110 South Side Canal near Dundee, Tex.	D	Wichita County W.I.D. No. 2	Station needed for operational purposes and inventory of water diverted from Lake Diversion.
0802536D Sabine River at Toledo Bend Dam near 8urkeville, Tex.	D,Qn	Sabine River Compact Administration	Station requested by Sabine River Compact Administration to meter releases from Toledo Bend Reservoir.
08D42650 North Creek SWS 28-A near Jacksboro, Tex.	D	Tarrant County W.C. & I.D. No. 1	To obtain hydrologic data which will aid in determining the effect of floodwater-retarding structures on the regimen of streamflow at downstream points.
08067300 Cedar 8ayou near Crosby, Tex.	D,Qd, Qp,Qn	Texas Water Quality Board through Texas Water Development 8oard	Station to be converted from partial-record to continuous-streamflow station to provide additional information to study the characteristics of quality and quantity of inflow into Galveston 8ay.
08073600 8uffalo Bayou at West 8elt Drive, Houston, Tex.	D	Corps of Engineers, Galveston District	Station needed to better define inflow into 8uffalo 8ayou from an urbanized area.
08075730 Vince Bayou at Pasadena, Tex.	D,Qd, Qp,Qn	Texas Water Quality 8oard through Texas Water Development 8oard	Station to be converted from partial-record to continuous-streamflow station to provide additional information to study the characteristics of quality and quantity of inflow into Galveston 8ay.
08076700 Greens 8ayou at Ley Road, Houston, Tex.	D,Qd, Qp,Qn	City of Houston	Do
08188610 Guadalupe-8lanco River Authority Calhoun Flume No. 2 near Long Mott, Tex.	D	Guadalupe-Blanco River Authority	Station needed to measure a major diversion from the Guadalupe and San Antonio River 8asins.
08189085 Saint Charles Bay near Fulton, Tex.	G	Corps of Engineers, Galveston District	Records needed to define hydrologic regimen of Saint Charles 8ay.
08189825 Aransas Bay near Rockport, Tex.	G	do	Records needed to define hydrologic regimen of Aransas 8ay.
08189895 Redfish 8ay (SH 361) near Aransas Pass, Tex.	G	do	Records needed to define hydrologic regimen of Redfish Bay.
08189945 Corpus Christi Bay near Ingleside, Tex.	G	do	Records needed to define hydrologic regimen of Corpus Christi Bay.
08189965 Nueces 8ay (Whites Point) near Corpus Christi, Tex.	G	do	Records needed to define hydrologic regimen of Nueces 8ay.
D8211505 Nueces Bay (mouth at U.S. 181) near Corpus Christi, Tex.	G	do	Do
0B3732D0 Cibolo Creek at Presidio, Tex.	D	Corps of Engineers, Albuquerque District	Station established to provide design for proposed flood-control project.

Name of station	Type of record	Cooperation with USGS	Purpose of station and remarks
		Stations to be Discontinued	
08063020 Cedar Creek at Trinidad, Tex.	D,Qd	Tarrant County W.I.D. No. 1	Station discontinued because of backwater from the Trinity River.
08065500 Trinity River near Midway, Tex.	D,Qd, Qn	Texas Water Development Board	Station discontinued because of backwater from Livingston Reservoir.
08164975 Intracoastal Waterway at Port O'Connor, Tex.	G	Corps of Engineers, Galveston District	Station discontinued because record was not representative of tide conditions in this area.
08182400 Calaveras Creek near Elmendorf, Tex.	D	Texas Water Development Board	Sufficient data have been collected to satisfy project objectives.

Ground-Water Records

A network of observation wells for observing fluctuations in ground-water levels, changes in chemical quality of ground water, and subsidence of the land surface is maintained in areas of large ground-water development. The periodic collection of ground-water data can be used in solving such specific problems as over-development and its relation to pumping costs, relationship of recharge to discharge of an aquifer, and the relationship of the quality of the ground water to the development and use of the water in storage.

The observation-well network is confined to the areas of continuing ground-water studies in the Houston District, Galveston County and adjacent areas, San Antonio area and Balcones Fault Zone, El Paso area, and Orange County and adjacent areas. As of June 30, 1971, the Geological Survey was monitoring more than 1,200 wells. The types and numbers of observation wells programmed for the 1972 fiscal year by areas are given below.

Area	Water Levels		Chemical Quality	Subsidence
	Periodic	Continuous		
Houston district	500	6	90	1
Galveston County and adjacent areas	90	2	35	0
San Antonio area and Balcones Fault Zone	325	18	178 a/	0
El Paso area	244	10	33	0
Orange County and adjacent areas	87	1	54	0

a/ 120 for preliminary analyses (semi-annual);
18 for tritium analyses; and
40 for some, but not all, inorganic, biologic, pesticide, and minor element analyses.

PROJECT STUDIES

Hydrologic Studies of Small Watersheds

The U.S. Soil Conservation Service (SCS) has an extensive program of constructing floodwater-retarding structures in small watersheds in Texas. These structures, which are designed to control floodflows and soil erosion, will have varying but important effects on the natural surface- and ground-water resources of river basins, especially where a large number of them are built. The need has grown for basic hydrologic data on these small watersheds to compare the hydrology under natural and developed conditions. It is, therefore, essential that the hydrologic studies determine the extent to which the floodwater-retarding structures affect the volume and mode of occurrence of runoff.

The specific objectives of these studies are:

(1) To determine the net effect of floodwater-retarding structures on the regimen of streamflow at downstream points.

(2) To determine the effectiveness of the structures as ground-water recharge facilities.

(3) To determine the effect of the structures on the sediment yield at downstream points.

(4) To develop relationships between maximum rates and volumes of runoff with rainfall in small natural watersheds.

(5) To develop a stream-system model for basins with floodwater-retarding structures.

(6) To determine the minimum instrumentation necessary for estimating the flood hydrographs below a system of structures, as needed for downstream water-management operations.

Hydrologic studies of SCS-developed areas in Texas, which were started in 1951, are now being made by the Geological Survey in 12 small watersheds to provide the needed data for analyses. The U.S. Soil Conservation Service, Texas Water Development Board, San Antonio River Authority, city of Dallas, and the Tarrant County Water Control and Improvement District No. 1 are cooperating with the Geological Survey in these studies. The 12 study areas are chosen on a Statewide basis to sample watersheds having different rainfall, topography, geology, and soils. In five of the study areas, streamflow and rainfall records were collected prior to construction of the floodwater-retarding structures, thus affording the opportunity for analyses of the hydrologic conditions before and after construction.

The 12 study areas, which are in four major river basins, are North Creek, Elm Fork Trinity River, Little Elm Creek, Honey Creek, and Pin Oak Creek, all in the Trinity River Basin; Green Creek, Cow Bayou, Little Pond-North Elm Creeks, in the Brazos River Basin; Deep Creek and Mukewater Creek in the Colorado River Basin; and Escondido Creek and Calaveras Creek in the San Antonio River Basin.

The long-range plan for the small-watershed studies specifies that the data-collection program in each study area will be "skeletonized" when the effect of floodwater-retarding reservoirs on volume of downstream runoff has been defined. In keeping with this long-range plan, the data-collection program in the Escondido Creek study area was "skeletonized" on October 1, 1970. Four other study areas were skeletonized at an earlier date. (Green Creek study area in 1967; Elm Fork Trinity River and Calaveras Creek study areas in 1968; and Honey Creek study area in 1969.) Collection of runoff data was discontinued at nine of the 11 floodwater-retarding reservoirs and rainfall-data collection was discontinued at six of the 12 rain gages in the study area. Continuation of a reduced data-collection program is necessary to achieve the other objectives as outlined in the long-range plan.

During the 1971 fiscal year, interpretive reports on studies in Calaveras Creek and Little Pond-North Elm Creeks were approved and released for publication. These two reports are presently awaiting publication by the Texas Water Development Board (TWDB). An interpretive report, which compared mass-transfer and climatic-index evaporation data collected on eight of the 12 study areas, was also approved and is awaiting publication by the TWDB. Basic-data reports, which present a compilation of the annual hydrologic data, were also prepared for each study area.

During the 1972 fiscal year, anticipated changes in the data-collection phase of the small-watershed studies include: (1) Data collection in the Deep Creek study area will be "skeletonized" October 1, 1971; (2) hydrologic instrumentation in the Calaveras Creek study area will be reduced effective October 1, 1971, to one continuous reservoir-level recording gage and two recording rain gages; (3) an interpretive report for the Honey Creek study area will be prepared for the period 1953-70.

Urban Hydrology Studies

Society is confronted with the most urgent water problems in urban areas, where residential, commercial, and industrial complexes must be protected against potentially destructive floods; and where lives and vast sums of money can be saved if metropolitan drainage systems and water-control facilities are properly designed.

Because undeveloped land is being converted to urban use, the amount of impervious surface area is increased, which results in a change in the runoff pattern. Higher peak discharges may result and may be accompanied by more rapid removal of the storm runoff. Drainage systems that were constructed prior to urbanization must be redesigned to function properly under conditions of ultimate land development. Because of these requirements, hydrologic data are needed to define the effects of urbanization on the magnitude of floodflow and runoff from small drainage areas.

The Geological Survey, in cooperation with State and local agencies, is making hydrologic studies in the Austin, Dallas, Dallas County, Houston, Fort Worth, and San Antonio areas. These studies will provide data necessary for defining the changes in storm runoff resulting from progressive urban development and for defining flood boundaries and depths of inundation for floods of various magnitudes and frequencies.

Data collection during the 1972 water year will continue at the same level as in 1971. Basic-data reports are published annually. An interpretive report on the urban hydrology of Houston will be published in fiscal year 1972. An interpretive report to evaluate the effects of urbanization in the Dallas metropolitan area is scheduled for fiscal year 1972.

Austin Project

The Austin project, which began in 1954, is in cooperation with the Texas Water Development Board. Specific objectives of the project are to provide basic rainfall and runoff data; to provide data showing the effects of progressive urbanization on infiltration, rates of peak discharge, and rainfall-runoff relations. The project also provides applied research facilities for students at the University of Texas.

The study involves the collection of rainfall and runoff data in the Waller Creek basin-- a 4.13-square-mile urban watershed in Austin-- and in the Wilbarger Creek basin-- a 4.61-square-mile rural watershed which is 15 miles northeast of Austin and which is comparable in size, climate, and geology to the Waller Creek study area. The data collected in the Wilbarger Creek area will be used for comparison.

Activity in the Austin project during 1971 was expanded to include periodic chemical-quality sampling at two streamflow gaging stations. Data are being collected from three recording and three nonrecording rain gages and from the two continuous-record stream-gaging stations in the urban watershed of Waller Creek. Three recording rain gages and one continuous-record stream-gaging station collect data from the Wilbarger Creek watershed.

Data collection during the 1972 water year will continue at about the same level as in 1971. Basic-data reports, which compile graphical and tabular data on the rates and volumes of rainfall and runoff from major storms each year, will continue to be prepared annually.

Houston Project

The Houston project, which began in 1964, is in cooperation with the city of Houston and the Texas Water Development Board. Objectives of the project are to provide data on the magnitude, frequency, and changes in characteristics of floods that result from progressive urban development.

The data-collection network consists of seven continuous-record stream-gaging stations, 17 crest-stage partial-record stations (each having recording rain gages), and five weighing-type recording rain gages.

The data-collection program in cooperation with the city of Houston and the Texas Water Development Board was expanded during the 1969 fiscal year to include water-quality studies. Samples were collected and analyzed periodically from 11 sites and results of these analyses will be included in the annual basic-data report. Analyses scheduled are: Standard chemical, nutrients, BOD, pesticides, and sediment.

The data-collection program in cooperation with the city of Houston and the Texas Water Development Board will be expanded during the 1972 fiscal year. The expanded program will include periodic chemical-quality sampling at six additional sites in addition to samples for coliform counts and minor elements analyses at 17 sites.

An interpretive report was started in 1970 and is scheduled for completion in 1972. Data collection for 1972 will continue at about the same level as in 1971. Basic-data reports, presenting graphical and tabular data for rates and volumes of rainfall and runoff, will continue to be prepared annually.

Dallas Project

The Dallas Project, which began in 1961, is in cooperation with the city of Dallas. Data collection is expected to permit analyses aimed at achieving the following objectives: To define the changes in storm runoff resulting from progressive urban development; to define the frequency and magnitude of floods on small urban watersheds; and to define flood boundaries and depths of inundation for floods of various magnitudes and frequencies in and along streams traversing the Dallas metropolitan area.

Data collection in 1972 in Dallas will be expanded slightly by the addition of 10 flood-profile stations on Jackson Branch and Dixon Branch (White Rock Creek tributaries). Rainfall and flood-stage or discharge data will continue to be collected at six continuous-record stream-gaging stations, 11 crest-stage partial-record stations, 79 flood-profile stations, and 32 recording rain-gage stations. This extensive hydrologic network covers the White Rock Creek, Turtle Creek, Bachman Branch, Joes Creek, Fivemile Creek, Cedar Creek, and Coombs Creek watersheds in Dallas.

Basic-data reports, presenting graphical and tabular data for rates and volumes of rainfall and runoff each year, will continue to be prepared annually. An interpretive report to evaluate the effects of urbanization in the Dallas metropolitan area is scheduled for the 1973 fiscal year.

San Antonio Project

The San Antonio project was initiated in 1968 in cooperation with the Texas Water Development Board. Objectives of the project are to collect data on rainfall and runoff in an urban area in order to define the effects of urbanization on the regimen of streamflow.

The data-collection network consists of four continuous streamflow recorders, six stage-rainfall (dual-digital) gages, and nine recording rain gages.

The data-collection program was expanded during the 1969 fiscal year. Samples were collected and analyzed periodically from 11 streamflow sites. Results of these analyses will be included in the annual basic-data report. Analyses scheduled are: Standard chemical, nutrients, BOD, pesticides, and sediment. The data-collection program for 1971 was expanded slightly by the addition of a sediment station at Olmos Creek at Dresden Drive.

Data collection during the 1972 water year will continue at about the same level as in 1971. Basic-data reports will continue to be published at the end of each water year.

Fort Worth Project

The Fort Worth project was initiated during the 1969 fiscal year in cooperation with the city of Fort Worth. Objectives of the project are to provide data for a logical approach to flood-zoning and flood-protection problems, and to analyze the effects of progressive urbanization on runoff. The data will also be useful in the design of storm sewers, culverts, and bridges.

The data-collection network consists of two continuous streamflow recorders, two stage-rainfall partial-record recorders, five rainfall recorders, and 19 crest-stage flood-profile gages. These instruments will be located in the Little Fossil and Dry Branch watersheds.

During 1970, the data-collection network was expanded by the addition of three continuous streamflow stations and four recording rain gages in the Sycamore Creek watershed and a special study area (Seminary-South Shopping Center). The data-collection network was expanded during the 1971 fiscal year by the addition of 16 crest-stage flood-profile gages in the Sycamore Creek watershed.

Data collection during the 1972 water year will continue at about the same level as in 1971. Basic-data reports will continue to be published at the end of each water year.

Dallas County Project

The Dallas County urban hydrology study was initiated during the 1969 fiscal year in cooperation with the Dallas County Department of Public Works. Specific objectives of the project are to provide data necessary for a logical approach to flood-zoning and flood-protection problems and to analyze the effects of progressive urbanization on runoff. These data will also be useful in the design of storm sewers, culverts, and bridges. The study area constitutes all of Dallas County exclusive of the city of Dallas and contains many rapidly urbanizing communities. Those cities in the 20,000 to 70,000 population class include: Farmers Branch, Garland, Grand Prairie, Irving, Mesquite, and Richardson. Other communities (less than 11,000 population) include: Cedar Hill, Duncanville, DeSoto, Kleberg, Lancaster, Rowlett, Seagoville, and Sunnydale.

The first year's instrumentation consisted of one continuous streamflow recorder, two stage-rainfall (dual-digital) recorders, seven rain-gage recorders, and 21 flood-profile crest-stage gages. These instruments are located in the Duck Creek and South Mesquite watersheds.

During the 1970 fiscal year, the basic-data network was expanded by instrumenting Tenmile Creek watershed with one continuous streamflow station, eight flood-profile crest-stage gages, and five recording-rain gages.

Data collection during the 1972 water year will continue at about the same level as in 1971. Basic-data reports will be prepared at the end of each water year.

Flood Stages and Discharges for Small Stream in Texas (Highway Program)

The highway program, which began in 1965, is in cooperation with the Texas Highway Department and the U.S. Department of Transportation, Federal Highway Administration. The objective of the project is to define the frequency of floods on small rural watersheds having drainage areas of less than 20 square miles. This information is needed to establish criteria for properly designing culverts and bridges on highways. Toward this end, 150 crest-stage partial-record stations have been established throughout Texas. Data on flood magnitude and volume and on rainfall amounts and intensities are being obtained at each station. The project is expected to operate for 10 or more years before sufficient data are obtained to accomplish the objective.

The first report--a compilation of all peak-discharge data collected in Texas through September 30, 1963, for streams draining about 100 square miles or less--was printed in 1966. This report, entitled "Floods on Small Streams in Texas," was released in January 1966, as Texas District Open-File Report No. 89.

Interim Report No. 85-2 was released in December 1967, as Texas District Open-File Report No. 107. This report contains a tabulation of the available maximum annual discharge data through the 1966 water year at 134 sites that have less than 20 square miles of drainage area. The report also contains a tabulation of the available rainfall and runoff data from significant storms at 120 sites.

Interim Report No. 85-3 was distributed in May 1969. This report contained data through the 1967 water year for 185 sites.

Interim Report No. 85-4 was distributed in May 1971. This report contains data through the 1968 water year for 225 sites.

Interim Report No. 85-5 will be distributed in January 1972. This report contains data through the 1969 water year for 225 sites.

The program for the 1972 fiscal year will be a continuation of the 1971 program.

Chemical and Physical Characteristics of Water in Estuaries of Texas

This study, begun in October 1967, is in cooperation with the Texas Water Development Board. The full development of the water resources of Texas must provide for the use and preservation of the valuable water resources of the estuaries. The objective of the study is to collect specific information on the quality of water. Data collected include temperature, pH, dissolved constituents, concentration of nutrients, (phosphate and nitrogen compounds), minor elements, water velocities and directions, and other data necessary to define the occurrence, source, and distribution of nutrients; current patterns, directions and rates of movement; and the physical and organic water quality in areal distribution and time variation.

The major effort has been expended on the Sabine-Neches, Lavaca-Tres Palacios, Guadalupe, and Nueces estuaries, but data are also obtained on other estuaries of the Texas Coast. Data collection in 1972 fiscal year will be concentrated in the Guadalupe, Mission-Aransas, and Nueces estuaries.

Special investigations to determine the quantity and quality of fresh-water inflow and the exchange of water between Mission-Aransas estuary or Nueces estuary and the Gulf of Mexico will be made during fiscal year 1972.

To supplement available tide-stage records being obtained by the U.S. Army Corps of Engineers and U.S. Geological Survey, 19 tide-stage gages funded by the Corps of Engineers were to be operated by the Geological Survey during 1972. Nine additional tide-stage gages are operated as part of the cooperative program with the Texas Water Development Board.

The basic data will be released to interested agencies on as timely a basis as possible and will be released in an annual basic-data compilation. Interpretive reports will be prepared as the data warrants.

Pesticides Program

The Water Resources Division pesticides laboratory in Austin makes monthly analyses for a Federal network of stations on streams throughout the western states. Three stations in Texas are included in the network.

Programs in cooperation with the Texas Water Development Board provide for studies of the quantities of chlorinated hydrocarbon pesticides in water and bottom sediments at a network of surface-water stations; in drainage from rice-irrigation areas; in runoff in the Houston and San Antonio urban areas; and in selected wells in counties where ground-water studies are in progress.

County Ground-Water Appraisal Studies

The county ground-water appraisal studies are detailed studies that are designed to provide the refined data required for proper planning of the development of Texas water resources. These studies, in cooperation with the Texas Water Development Board, are primarily concerned with the occurrence, availability, dependability, quality, and quantity of the ground-water resources, particularly with reference to the sources of water suitable for public supply, industrial use, and irrigation.

The results of the county studies are presented in published reports containing analytical discussions of the geology and hydrology as related to ground water. These reports include tables of basic data and illustrations to portray conditions shown by these data.

The following county ground-water projects were in progress during the 1972 fiscal year:

Duval County
Brazos and Burleson Counties
Grimes County

Continuing Ground-Water Studies

The continuing ground-water studies are detailed studies that are designed to keep abreast of and to evaluate the effects of large withdrawals of ground water in the areas of concentrated pumping. The need for ground-water information in these areas is determined by the particular problems of the area, and the programs of continuing study are carefully planned to meet specific objectives.

Houston District

The ground-water study in the Houston District, which began on a more or less continuous basis in 1929, is in cooperation with the Texas Water Development Board and the city of Houston. The program proposed for 1972 is a continuation of basic-data collection. Items of work will include an inventory of all new large-capacity wells; periodic measurements of water levels in about 500 observation wells; operation and maintenance of six continuous water-level recorders and one compaction recorder; collection of water samples annually from about 90 wells for chemical analyses; conducting pumping tests on new large-capacity wells; and an inventory of annual municipal, industrial, and irrigation pumpage. Basic-data reports will be prepared periodically.

Galveston County

The ground-water study in Galveston County, which began in 1931, is in cooperation with the Texas Water Development Board and the city of Galveston. The program for several years has consisted of a compilation and tabulation of water records, including records of water-level fluctuations, changes in chemical quality, pumpage, and land-surface subsidence. For 1972, the program consists of semi-annual measurements of water levels in 90 observations wells; operation and maintenance of two continuous water-level recorders; observation of the chemical quality of water in 35 wells; inventory of all municipal and industrial pumpage; and observance of the effects of land-surface subsidence. Basic-data reports will be prepared periodically.

El Paso Area

The ground-water study in the El Paso area began in 1935 in cooperation with the Texas Water Development Board and the city of El Paso. The program for the 1972 fiscal year is in three parts. The first part of the program consists of a continuation of the collection of basic hydrologic data in the Hueco Bolson and Mesilla Valley; measuring about 200 wells annually, 10 semi-annually, 30 quarterly, four monthly, and 10 continuously with water-level records; inventorying all new wells, excluding shallow irrigation wells; making aquifer tests of large-capacity wells; and collecting water samples from about 33 wells.

The second and third parts of the program consist of: (1) Compiling and tabulating data and preparing maps needed for a mathematical model of the Hueco Bolson in Texas; and (2) preparing a report summarizing results of the water-budget study in El Paso and Mesilla Valleys through 1971.

San Antonio Area and Balcones Fault Zone

The ground-water study in the San Antonio area and Balcones Fault Zone, which began in 1949, is in cooperation with the Texas Water Development Board, Edwards Underground Water District, and the San Antonio City Water Board. The objectives of the study are to appraise quantitatively the ground-water resources in the San Antonio area and along the Balcones Fault Zone from Kinney County to the Hays-Travis County line and to continue to investigate the cause-effect relationships in the Edwards underground reservoir.

The 1972 program consists of continuing to collect and analyze the basic geologic and hydrologic data and to refine the previous geologic and hydrologic evaluations. Items of work include periodic measurements of water levels in 325 wells; operation and maintenance of 18 continuous water-level recorders on wells; collecting and compiling records from 10 rain-gaging stations; inventory of municipal, industrial, military, and irrigation pumpage, and spring discharge; inventory of new wells; collection of water samples semi-annually from about 178 wells for chemical analysis; and evaluation of records to determine stream-flow losses and recharge to the Edwards underground reservoir.

Orange County and Adjacent Areas

The ground-water study in the Orange County area, which began in 1967, is in cooperation with the Texas Water Development Board and the Sabine River Authority of Texas. The purpose of this study is to keep abreast of the effects of ground-water development in the area and especially to monitor the fresh-water - salt-water interface as a guide to future development of ground water in Orange and adjacent counties to prevent further salt-water intrusion. The magnitude of industrial and municipal development in the area greatly increases the gravity of the situation.

The 1972 fiscal year program will consist of the inventory of all new large-capacity wells, including the collection of drillers' logs, electrical logs, well-construction information, measurements of water levels in about 87 observation wells on a semi-annual basis, operation and maintenance of one continuous water-level recorder, and the location of addition wells suitable for water-level recorders. In addition, water samples from about 54 wells are to be collected annually for chemical analysis; annual municipal and industrial pumpage is to be inventoried; and all data currently and previously collected are to be analyzed, interpreted, and correlated. An interpretive report is to be prepared and will be available March 1972.

Other Interpretive Studies

Water Resources of Big Bend National Park

This study, begun in July 1966, is in cooperation with the National Park Service. The objective of the study is to determine the available sources of water for Big Bend National Park. The program in the 1972 fiscal year will include the drilling of a test hole near Oak Springs.

Artificial-Recharge Research on the High Plains of Texas and New Mexico

This research project, which began during the 1968 fiscal year, is financed wholly by Federal funds. The study will provide information needed in connection with a proposed large-scale project for importation of water to the High Plains. The study will also provide the opportunity for applied research on methods of artificial recharge. During the 1972 fiscal year, special emphasis is being placed on recharge from the surface through spreading ponds. Additional work is being done on problems associated with recharge through wells, such as the control of sediment in recharge water.

A report summarizing previous work on artificial recharge on the High Plains will be available in the 1972 fiscal year. A progress report summarizing the results of the research will also be available in 1972.

Evaluation of Water-Quality Records of Texas Streams

This study, begun in the 1971 fiscal year, is wholly financed by Federal funds. Historical records of inorganic chemical quality at points on selected streams are being analyzed by statistical techniques. The purposes are to determine the usefulness of computer-oriented analyses as tools of data evaluation and to learn the accuracy with which inorganic chemical constituents can be determined in a reduced data collection program using specific conductance or water discharge as an index variable.

Water Resources of Guadalupe Mountains National Park

This study was begun during the 1969 fiscal year in cooperation with the National Park Service. The specific objectives are to appraise the water resources of this newly established park. Because the present water supply of the area--obtained from wells and springs--is inadequate for anticipated needs, the study will include a complete inventory of wells and springs with particular attention to those areas of immediate need (Frijoles Ranch site, McKittrick Canyon, and the Bowl). In 1972, two test holes will be drilled at or near the site of the Visitor's Center.

Hydrologic Research Studies of the Edwards and Associated Limestones

This ground-water study is in cooperation with the Texas Water Development Board, the Edwards Underground Water District, and the San Antonio City Water Board. All indications, both past and present, indicate that the Edwards Limestone Reservoir will, in time, become totally developed (in the amount of the natural recharge), and that it will then become necessary to integrate the use of water from the Edwards with water imported from other sources. At that time, it will be necessary to know in as much detail as possible how to get the most water from the Edwards with the least waste, with a minimum conflict between users, and with a minimum detriment to those users who are in less favorable locations.

This study will provide for the complete appraisal of the availability of water in the Edwards Limestone aquifer, thereby furnishing valuable and detailed information not now available to all agencies that may be concerned with water management.

During the 1972 fiscal year, four test holes will be drilled and cored, and as many wells as time and funds permit will be geophysically logged. In addition, geothermal, tracer, and stable isotope studies, which will be useful in determining not only the rates of movement in the aquifer but also the permeability and porosity of the aquifer, will be included in the program. The relationship between precipitation and recharge will be studied using multiple-regression techniques.

Analog-Model Study of Ground Water in the Houston District

In 1962-63, an analog model was made of the aquifers underlying the Houston District. This work was done in cooperation with the city of Houston and the Texas Water Development Board. The model successfully duplicated the performance of the aquifer in the heavily developed areas in the immediate vicinity of Houston, but in the adjoining rice-irrigation area, the model failed to duplicate the history of performance, nor did the model successfully duplicate the performance of the Alta Loma Sand, one of the layers modeled. Although the model served the immediate purpose of the city of Houston, future plans for ground-water development by the city required that the model be refined so that the conditions in the area to the west of the city, including the rice-irrigation area, be properly simulated. This project is in cooperation with the city of Houston and the Texas Water Development Board. The construction of the model is scheduled for completion during the 1972 fiscal year, and the report will be completed in 1973.

Relationship of Ground Water to Surface Water at the Proposed Palmetto Bend Reservoir

At the request of the Bureau of Reclamation, the Geological Survey initiated this project in the 1971 fiscal year. The objectives of the project were to evaluate the possible capture of base flow of the Lavaca and Navidad Rivers because of heavy ground-water pumping, and to outline areas and predict magnitudes of land-surface subsidence. Conclusions may indicate need for the Bureau to reassess inflow and yield of the proposed reservoir and to assess effects of subsidence on height and length of the dam embankment, on spillway design, and also on backwater and surface-drainage problems--all important to successful construction and operation of the Bureau's Palmetto Bend project. The results of the investigation will be released in an open-file report that will be prepared by the end of the 1972 fiscal year.

Ground-Water Study of the Upper Red River Basin

At the request of the Corps of Engineers, Tulsa District, the Survey will make a study of ground-water availability in the Red River Basin above Denison Dam. The overall project will be under the direction of the Oklahoma District. Personnel of the Texas District will be assigned to the project to carry out the work in the Texas part of the basin. Work planned for the 1972 fiscal year is a compilation of data for the Texas part of the project. A report will be available, at least in preliminary form, by the end of the 1972 fiscal year.

Trinity River Alluvium Study

At the request of the U.S. Corps of Engineers, Fort Worth District, the Geological Survey initiated a study of the Trinity River alluvium at the beginning of the 1972 fiscal year. The objectives of the study are to (1) define the ground-water conditions in the alluvium of the Trinity River Valley between Dallas and the Gulf Coast, and (2) project the effects on the ground-water system by the impoundment of water behind navigational locks and dams. This work is in connection with the canalization of the Trinity River by the Corps.

Work planned during the 1972 fiscal year includes a drilling program in the alluvium along a segment of the river reach, inventory of wells, establishment of a water-level observation-well program, collection of water samples for chemical analyses, performance of pumping tests, collection of formation samples for laboratory analyses, and the initial construction of a digital model for a segment of the alluvium. A progress report will be prepared at the end of the fiscal year.

Rio Grande Environmental Study

The present water needs (exclusive of irrigation) of the El Paso area are supplied almost entirely from ground-water sources. The known available supplies of fresh ground water are large, but for future growth, additional sources of water need to be identified. The need for the study is to provide reliable information on the amounts and quality of fresh and slightly saline ground water available for development in the Salt Basin, Quitman and Presidio Bolsons, Mesilla Valley and La Mesa Bolson.

The 1972 program will include: Reviewing available data on the geohydrology of the bolsons; planning geophysical and test-drilling operations and beginning geophysical (magnetometer, gravity, and seismic) surveys; obtaining permits for rights-of-access to private lands for geophysical and drilling operations; and inventorying major wells in the bolsons.

Liquid-Waste Disposal at the Linfield Disposal Site in Dallas

The study, which is in cooperation with the city of Dallas, is being conducted to determine if liquid wastes, which are being disposed of in open pits in a land-fill area, have moved downward to the shallow water table, and if so, to determine the dispersal pattern within the ground-water reservoir. Several test holes have been drilled in the area, and water samples have been collected for chemical analyses. During the 1972 fiscal year, additional samples will be analyzed. After completion of the project, the data will be released to the open file.

Land-Surface Subsidence in the Baytown Area

Extensive development of ground water supplies and the production of oil and gas in the greater Houston area has caused large pressure declines in the fresh-water aquifers and petroleum reservoirs, resulting in compaction of the fine-grained sediments. In some parts of the area, the compaction has resulted in as much as 6 feet of land-surface subsidence. Near the bays, the subsidence has caused tidal flooding which will probably require the construction of protecting levees.

The objectives of this study, which is in cooperation with the Corps of Engineers, is to determine the rates and amount of subsidence in the Baytown area, and to predict the rate and amount of subsidence for planning and constructing the proposed levee or other protective measures.

During fiscal years 1972 and 1973, data on the relation of pressure decline to compaction will be collected. These data include inventories or ground-water pumpage and oil and gas production and a delineation of the pressure decline due to each. A study will be made of the subsurface deposits by the use of drillers' logs and electrical logs to determine the thickness of clay beds and sand beds and to determine the composite clay thickness. Two wells will be drilled to obtain clay cores and to install pore-pressure measuring devices. Water-level measurements will be made to relate the data to data from a relevelling program to the conducted by the Corps of Engineers.

Mapping of Flood-Prone Areas

The U.S. Geological Survey is mapping flood-prone areas in Texas by delineating on existing topographic maps the outline of the 100-year flood. This program is part of a nationwide federal program designed to aid in reducing flood losses and damage. In addition, the Geological Survey in cooperating with the Department of Housing and Urban Development is mapping the flood hazards in specific, mainly urban, areas so that actuarial rates can be assigned by the Federal Insurance Administration. The programs will continue through fiscal year 1972, and additional maps and phamphlets, which show the areas of potential flood damage, will be issued as they are completed.

Galveston Bay Inflow Study

The objectives of this project, which is in cooperation with the Texas Water Development Board, is to determine the quantity and quality of runoff from rural and urban areas to the Galveston Bay system. During fiscal year 1972, data collection will include tributary discharge, inorganic and organic chemical parameters, bacteria counts, and pesticide concentration at 31 sites. Analyses and interpretations will include projections for ungaged areas and calculations of contributions to the bay in time and place.

Ground-Water Pollution Study of Toledo Bend Reservoir

An expected large increase in the disposal of sewage by septic tanks along the shoreline of Toledo Bend Reservoir is a possible source of pollution of the impounded water. An understanding of the movement of the shallow ground water, including any effluent, will be the basis for controlling and regulating the sewage disposal.

Work during the 1972 fiscal year, in cooperation with the Sabine River Authority of Texas, will be directed toward determination of the direction of flow and gradient of the water table and determination of the chemical and biological quality of the shallow ground water within a 2-mile zone bordering the reservoir, by using a network of selected wells, a program will be established to monitor periodically the quality of the ground water and the fluctuations of the water table.

Time-of-Travel Studies of the Sabine River

The objectives of this project, which is in cooperation with the Sabine River Compact Administration, is to field check the results of previous studies which determined the stream velocity by developing equations based on hydraulic geometry. During fiscal year 1972, three time-of-travel dye studies will be conducted on selected reaches of streams in the Sabine River Basin and the results will be released in an open-file report.

Basic-Data Reports

Water Resources Data for Texas

Water resources data for Texas, 1970 - Part I: Surface-water records. Records for the 1970 water year (October 1969 - September 1970), published as a U.S. Geological Survey annual report.

Water resources data for Texas, 1969 - Part II: Water-quality records. Records for the 1969 water year (October 1968 - September 1969), will be published as a U.S. Geological Survey annual report.

Hydrologic Studies of Small Watersheds

Annual compilation and analysis of hydrologic data for North Creek, Trinity River Basin, Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Elm Fork Trinity River, Trinity River Basin, Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Little Elm Creek, Trinity River Basin, Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Honey Creek, Trinity River Basin, Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Pin Oak Creek, Trinity River Basin, Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Green Creek, Brazos River Basin, Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Mountain Creek, Trinity River Basin, Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Cow Bayou, Brazos River Basin, Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Deep Creek, Colorado River Basin, Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Mukewater Creek, Colorado River Basin, Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Escondido Creek, San Antonio River Basin, Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Calaveras Creek, San Antonio River Basin, Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for Little Pond and North Elm Creeks, Brazos River Basin, Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Urban Hydrology Studies

Annual compilation and analysis of hydrologic data for urban studies in the Fort Worth, Texas, metropolitan area, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for urban studies in the Houston, Texas, metropolitan area, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for urban studies in the Dallas, Texas, metropolitan area, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for urban studies in the Austin, Texas, metropolitan area, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for urban studies in the Bryan, Texas, metropolitan area, 1970. Limited number of copies to be reproduced by the Texas District.

Annual compilation and analysis of hydrologic data for urban studies in the San Antonio, Texas, metropolitan area, 1970. Limited number of copies to be reproduced by the Texas District.

Flood Stages and Discharges for Small Streams in Texas (Highway Program)

Flood stages and discharges for small streams in Texas, 1969. Limited number of copies to be reproduced by the Texas District.

Flood stages and discharges for small streams in Texas, 1970. Limited number of copies to be reproduced by the Texas District.

Ground-Water Basic-Data Reports

Records of precipitation, water levels, and ground-water recharge to the Edwards and associated limestones, San Antonio area, Texas, 1971. This report will be published as an Edwards Underground Water District Bulletin.

Ground-water discharge from the Edwards and associated limestones, San Antonio area, Texas, 1971. This report will be published as an Edwards Underground Water District Bulletin.

Development of ground water in the Orange County area, Texas and Louisiana, 1963-71. This report will be published as a Texas Water Development Board report.

Drillers' logs of wells in Harris County, Texas. This report will be published as a Texas Water Development Board report.

Chemical analyses of ground water from wells in Harris County, Texas. This report will be published as a Texas Water Development Board report.

Records of wells in Harris County, Texas. This report will be published as a Texas Water Development Board report.

Records of wells, drillers' logs, and chemical analyses of ground water in Galveston County, Texas. This report will be published as a Texas Water Development Board report.

Other Basic-Data Reports

Water-quality records for the Hubbard Creek Watershed, Texas, October 1967 - September 1969. Limited number of copies to be reproduced by the Texas District.

Water-quality records for the Hubbard Creek Watershed, Texas, October 1969 - September 1970. Limited number of copies to be reproduced by the Texas District.

Chemical and physical characteristics of water in estuaries of Texas, October 1968 - September 1969. This report will be published as a Texas Water Development Board report.

Chemical and physical characteristics of water in estuaries of Texas, October 1969 - September 1970. This report will be published as a Texas Water Development Board report.

Water-quality records for selected reservoirs in Texas and adjoining areas, 1970-71. Limited number of copies to be reproduced by the Texas District.

Biochemical-oxygen-demand, dissolved-oxygen, selected-nutrients, and pesticide records of Texas surface waters, 1970. This report will be published as a Texas Water Development Board report.

Biochemical-oxygen-demand, dissolved-oxygen, selected-nutrients, and pesticide records of Texas surface waters, 1971. This report will be published as a Texas Water Development Board report.

Pesticides in western streams, 1969-71. This report will be published in the Pesticides Monitoring Journal.

Analytical or Interpretive Reports

Hydrologic Studies of Small Watersheds

Hydrologic studies of small watersheds, Green Creek, Brazos River Basin, Texas, 1955-66. This report has been released to the open file and will be published as a Texas Water Development Board report.

Hydrologic studies of small watersheds, Calaveras Creek, San Antonio River Basin, Texas, 1955-68. This report is scheduled to be published as a Texas Water Development Board report.

Hydrologic studies of small watersheds, Elm Fork Trinity River, Trinity River Basin, Texas, 1957-68. This report is scheduled to be published as a Texas Water Development Board report.

Hydrologic studies of Little Pond Creek and North Elm Creek watersheds, Brazos River Basin, Texas, 1962-69. This report will be released as a U.S. Geological Survey open-file report.

Hydrologic studies of small watersheds, Honey Creek, Trinity River Basin, Texas, 1953-69. This report is scheduled to be published as a Texas Water Development Board report.

Low-Flow Studies

Quantity of low flow in Barton Creek, Texas, July 6-8, 1970, and October 1-3, 1970. A limited number of copies will be reproduced by the Texas District.

Reconnaissance Studies of the Chemical Quality of Texas Streams

Reconnaissance of the chemical quality of surface waters of the Nueces River Basin, Texas. This report was published as Texas Water Development Board Report 134.

Reconnaissance of the chemical quality of surface waters of the Rio Grande Basin, Texas. This report will be published as a Texas Water Development Board report.

Reconnaissance of the chemical quality of the surface waters of the Coastal Basins of Texas. This report was published as Texas Water Development Board Report 130.

County Ground-Water Appraisal Studies

Ground-water resources of Chambers and Jefferson Counties, Texas. This report was published as Texas Water Development Board report 153.

Ground-water resources of Montgomery County, Texas. This report was published as Texas Water Development Board Report 136.

Ground-water resources of Wheeler and eastern Gray Counties, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Brazoria County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Donley County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Dickens and Kent Counties, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Cass and Marion Counties, Texas. This report was published as Texas Water Development Board Report 135.

Ground-water resources of Navarro County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Washington County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Blanco County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Fort Bend County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Kleberg, Kenedy, and southern Jim Wells Counties, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Coke County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Hall and Briscoe Counties, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Hardeman County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Rains and Van Zandt Counties, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Floyd and Motley Counties, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Val Verde County, Texas. This report has been released to the open file and will be published as a Texas Water Development Board report.

Ground-water resources of Brazos and Burleson Counties, Texas. This report will be published as a Texas Water Development Board report.

Ground-water resources of Duval County, Texas. This report will be published as a Texas Water Development Board report.

Ground-water resources of Grimes County, Texas. This report will be published as a Texas Water Development Board report.

Other Analytical or Interpretive Reports

Reconnaissance of the oxygen balance and the variation of selected nutrients in the San Antonio River during low flow. This report has been released to the open file and will be published as a Texas Water Development Board report.

The water quality of Sam Rayburn Reservoir, eastern Texas. This report was published as U.S. Geological Survey Water-Supply Paper 1999-J.

Factors contributing to unusually low runoff during the period 1962-68 in the Concho River Basin, Texas. This report was reproduced by the Texas District and is to be published as a U.S. Geological Survey Water-Supply Paper.

Floods of September - October 1967 in south Texas and northeastern Mexico. This report is released to the open file and will be published by the U.S. Geological Survey as a Water-Supply Paper.

Artificial recharge operations on the southern High Plains of Texas and New Mexico. This report will be published as a U.S. Geological Survey Water-Supply Paper.

Artificial recharge research summary of investigations, 1970-71 fiscal years. This report will be released as a U.S. Geological Survey open-file report.

Urban hydrology of the Houston, Texas, metropolitan area. This report will be published as a U.S. Geological Survey Water-Supply Paper.

Development of ground water in the El Paso District, Texas, 1963-70. This report will be published as a Texas Water Development Board report.

Effects of ground-water development on the proposed Palmetto Bend Reservoir. This report will be released as a U.S. Geological Survey open-file report.

Water budget and quality of water of Hubbard Creek Reservoir, Texas, 1963-67 water years. This report will be published as a Texas Water Development Board report.

Relation of ponded floodwater from Hurricane Beulah to ground water in Kleberg, Kenedy, and Willacy Counties, Texas. This report will be published as a Texas Water Development Board report.

Development of ground water in the Houston District, Texas, 1966-69. This report will be published as a Texas Water Development Board report.

A comparison of mass-transfer and climatic-index evaporation computations from small reservoirs in Texas. This report will be published as a Texas Water Development Board report.

Application of remote sensing techniques to estuarine studies. This report will be released as a U.S. Geological Survey open-file report.

SELECTED LIST OF AVAILABLE REPORTS OF GENERAL INTEREST

U.S. Geological Survey Professional Paper 433-K: Stream Dispersion at Selected Sites, by Richard G. Godfrey and Bernard J. Frederick. 38 p., 6 figs., 15 tables. Available from Superintendent of Documents - 55¢.

U.S. Geological Survey Professional Paper 562-D: Response of a Laboratory Alluvial Channel to Change of Hydraulic and Sediment-Transport Variable, by R. E. Rathbun, H. P. Guy, and E. V. Richardson. 32 p., 2 figs., 4 tables. 1969. Available from Superintendent of Documents - 40¢.

U.S. Geological Survey Professional Paper 650-D: Geological Survey Research, 1969, Chapter D. 298 p. Available from Superintendent of Documents - $3.75.

U.S. Geological Survey Professional Paper 655-A: Objectives, Methods, and Environment - Gila River Phreatophyte Project, Graham County, Arizona, by R. C. Culler and others. 25 p., 10 illus. Available from Superintendent of Documents - 45¢.

U.S. Geological Survey Professional Paper 700-D: Geological Survey Research, 1970, Chapter D. Available from Superintendent of Documents - $3.75.

Texas Water Development Board Report 118: Systems Simulation for Management of a Total Water Resource, A Completion Report. Volume I - Introduction; prepared by the Texas Water Development Board and Water Resources Engineers, Inc. 83 p., 27 figs., 16 tables. Available from Texas Water Development Board, Austin, Texas 78711.

U.S. Geological Survey Water-Supply Paper 1840-C: Summary of Floods in the United States during 1964, by J. O. Rostvedt and others. 124 p., 58 figs., 29 tables. August 1970. Available from Superintendent of Documents - 60¢.

U.S. Geological Survey Water-Supply Paper 1898-B: Determination of the Manning Coefficient from Measured Bed Roughness in Natural Channels, by J. T. Limerinos. 47 p., 9 figs., 5 tables. 1970. Available from Superintendent of Documents - 35¢.

U.S. Geological Survey Water-Supply Paper 1899-K: A Glossary of Karst Terminology, compiled by Watson H. Monroe. August 1970. 27 p. Available from Superintendent of Documents - 25¢.

U.S. Geological Survey Water-Supply Paper 1946: Quality of Surface Waters of the U.S., 1965, Parts 7-8. Available from Superintendent of Documents - $3.50.

Circular 601-D: Water as an Urban Resource and Nuisance, by Harold E. Thomas and William J. Schneider. 9 p. August 1970. Free on application to the U.S. Geological Survey, Washington, D. C. 20242.

Circular 601-F: Hydrologic Implications of Solid-Waste Disposal, by William J. Schneider. 10 p., 2 figs., 2 tables. 1970. Free on application to the U.S. Geological Survey, Washington, D. C. 20242.

Circular 618: Reports and Maps of the Geological Survey Released Only in the Open Files, 1969, by Betsy A. Weld, Margaret S. Griffin, and George W. Brett. 23 p. August 1970. Free on application to the U.S. Geological Survey, Washington, D. C. 20242.

Saline Ground-Water Resources of the Rio Grande Drainage Basin - A Pilot Study, by T. E. Kelly, B. N. Mayers, and L. A. Hershey. Office of Saline Water Research and Development Progress Report No. 560.

SUMMARY OF COOPERATION

Organizations assisting in collecting data under cooperative agreements with the Geological Survey are:

Texas Water Development Board. Harry P. Burleigh, Executive Director; W. E. Tinsley, Chairman; Marvin Shurbet, Vice-Chairman; Robert B. Gilmore, Milton T. Potts, John H. McCoy, and Carl Illig, Members.

Texas Highway Commission. J. C. Dingwall, State Highway Engineer; D. C. Greer, Chairman; Herbert C. Petry, Jr. and Charles E. Simons, Members.

Pecos River Commission. John W. Odell, Commissioner representing the United States and Chairman; R. B. McGowen, Jr., Commissioner representing Texas; and Robert E. Pritchett, Commissioner representing New Mexico.

Sabine River Compact Administration. W. H. Robinson, Chairman; R. J. Palmer and H. B Myers for Louisiana; and J. M. Syler and Guy Cowser for Texas.

County of Dallas. Judson Shook, Director of Public Works.

City of Dallas. H. H. Stirman, Director of Public Works.

City of Fort Worth. J. M. Graham, Director of Public Works.

City of Houston. E. B Cape, Director of Public Works.

Assistance in the form of funds or services is furnished by the following Federal agencies:

Bureau of Reclamation, Department of the Interior.

Bureau of Sport Fisheries and Wildlife, Department of the Interior.

National Oceanic and Atmospheric Administration, Department of Commerce.

Environmental Protection Agency.

Department of Housing and Urban Development.

International Boundary and Water Commission, United States and Mexico, U.S. Section.

National Park Service, Department of the Interior.

Soil Conservation Service, Department of Agriculture.

U.S. Air Force, Department of Defense.

U.S. Army, Department of Defense.

U.S. Army, Corps of Engineers, Albuquerque District, New Mexico.

U.S. Army, Corps of Engineers, Fort Worth District, Texas.

U.S. Army, Corps of Engineers, Galveston District, Texas.

U.S. Army, Corps of Engineers, New Orleans District, Louisiana.

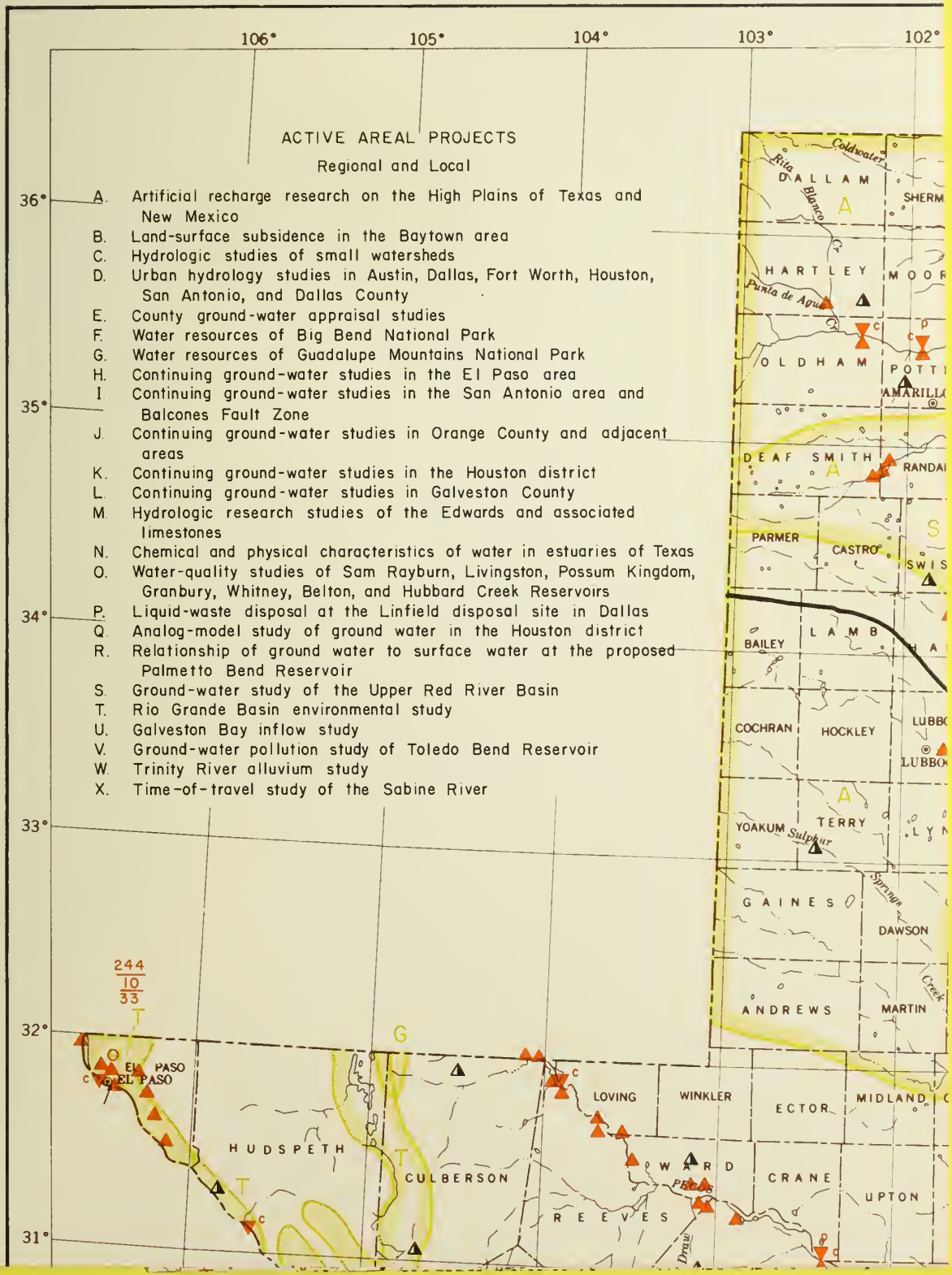
U.S. Army, Corps of Engineers, Tulsa District, Oklahoma.

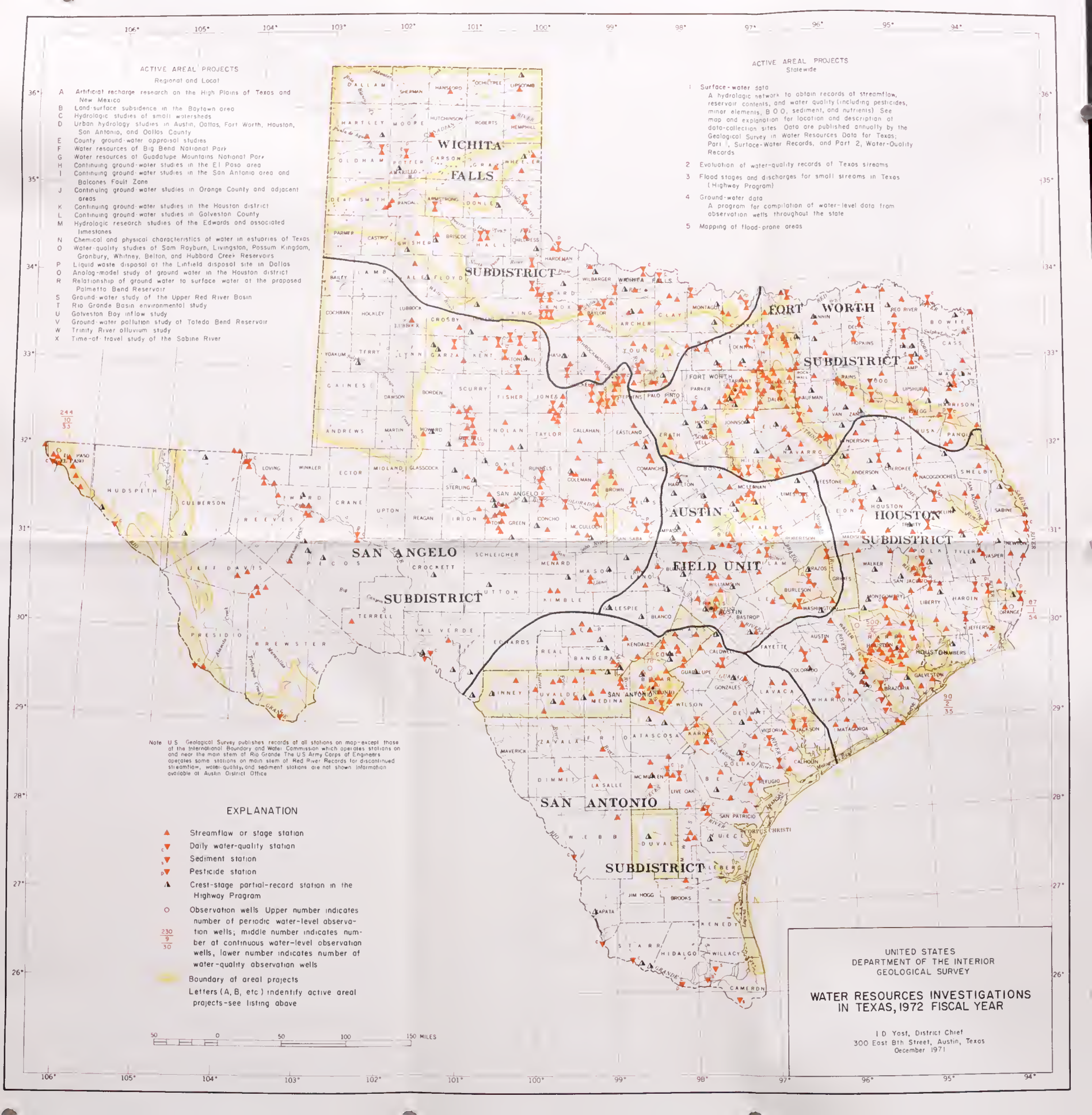
Assistance in the form of funds or services is rendered by the following organizations through the Texas Water Development Board:

Cities		
Alice	Clyde	Graham
Abilene	Corpus Christi	Houston
Arlington	Dallas	Lampasas
Austin	El Paso	San Angelo
Brady	Gainesville	Wichita Falls
Cleburne	Galveston	

Other Agencies

Athens Municipal Water District
Bexar-Medina-Atascosa Counties Water Improvement District No. 1
Bexar Metropolitan Water District
Bistone Municipal Water Supply District
Brazos River Authority
Colorado River Municipal Water District
Dallas County
Dallas Power and Light Company
Dow Chemical Company
Edwards Underground Water District
Greenbelt Municipal and Industrial Water Authority
Guadalupe-Blanco River Authority
Harris County Flood Control District
Houston Lighting and Power Company
Lower Colorado River Authority
Lower Neches Valley Authority
Palo Pinto Municipal Water District No. 1
Red Bluff Water Power Control District
Reeves County Water Improvement District No. 1
Richmond Rice Association
Sabine River Authority of Texas
San Antonio City Public Service Board
San Antonio City Water Board
San Antonio River Authority
San Jacinto River Authority
South Texas Water Company
Tarrant County Water Control and Improvement District No. 1
Texas Electric Service Company
Texas Water Quality Board
Trinity River Authority of Texas
Upper Guadalupe River Authority
Upper Neches River Municipal Water Authority
West Central Texas Municipal Water District
White River Municipal Water District
Wichita County Water Improvement District No. 2
Wood County


106°
105°
104°
103°
102°
36°
35°
34°
33°
32°
31°
ACTIVE AREAL PROJECTS
Regional and Local
A. Artificial recharge research on the High Plains of Texas and New Mexico
B. Land-surface subsidence in the Baytown area
C. Hydrologic studies of small watersheds
D. Urban hydrology studies in Austin, Dallas, Fort Worth, Houston, San Antonio, and Dallas County
E. County ground-water appraisal studies
F. Water resources of Big Bend National Park
G. Water resources of Guadalupe Mountains National Park
H. Continuing ground-water studies in the El Paso area
I. Continuing ground-water studies in the San Antonio area and Balcones Fault Zone
J. Continuing ground-water studies in Orange County and adjacent areas
K. Continuing ground-water studies in the Houston district
L. Continuing ground-water studies in Galveston County
M. Hydrologic research studies of the Edwards and associated limestones
N. Chemical and physical characteristics of water in estuaries of Texas
O. Water-quality studies of Sam Rayburn, Livingston, Possum Kingdom, Granbury, Whitney, Belton, and Hubbard Creek Reservoirs
P. Liquid-waste disposal at the Linfield disposal site in Dallas
Q. Analog-model study of ground water in the Houston district
R. Relationship of ground water to surface water at the proposed Palmetto Bend Reservoir
S. Ground-water study of the Upper Red River Basin
T. Rio Grande Basin environmental study
U. Galveston Bay inflow study
V. Ground-water pollution study of Toledo Bend Reservoir
W. Trinity River alluvium study
X. Time-of-travel study of the Sabine River
244
10
33
EL PASO
HUDSPETH
CULBERTSON
REEVES
LOVING
WINKLER
ECTOR
MIDLAND
WARD
CRANE
UPTON
ANDREWS
MARTIN
GAINES
DAWSON
YOAKUM
TERRY
COCHRAN
HOCKLEY
BAILEY
LAMB
PARMER
CASTRO
DEAF SMITH
OLDHAM
HARTLEY
DALLAM
Coldwater
Rita Blanco Cr.
Punta de Agua Cr.
Sulphur Springs Draw
Pecos R.


ACTIVE AREAL PROJECTS
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ACTIVE AREAL PROJECTS
Statewide
1 Surface-water data
A hydrologic network to obtain records of streamflow, reservoir contents, and water quality (including pesticides, minor elements, B O D, sediment, and nutrients) See map and explanation for location and description of data-collection sites Data are published annually by the Geological Survey in Water Resources Data for Texas; Part 1, Surface-Water Records, and Part 2, Water-Quality Records
2 Evaluation of water-quality records of Texas streams
3 Flood stages and discharges for small streams in Texas (Highway Program)
4 Ground-water data
A program for compilation of water-level data from observation wells throughout the state
5 Mapping of flood-prone areas
WICHITA FALLS SUBDISTRICT
FORT WORTH SUBDISTRICT
AUSTIN FIELD UNIT
HOUSTON SUBDISTRICT
SAN ANGELO SUBDISTRICT
SAN ANTONIO SUBDISTRICT
Note U S Geological Survey publishes records at all stations on map-except those at the International Boundary and Water Commission which operates stations on and near the main stem of Rio Grande The U S Army Corps of Engineers operates some stations on main stem of Red River Records for discontinued streamflow, water-quality, and sediment stations are not shown Information available at Austin District Office
EXPLANATION
Streamflow or stage station
Daily water-quality station
Sediment station
Pesticide station
Crest-stage partial-record station in the Highway Program
Observation wells Upper number indicates number of periodic water-level observation wells; middle number indicates number at continuous water-level observation wells, lower number indicates number of water-quality observation wells
Boundary of areal projects
Letters (A, B, etc) indentify active areal projects-see listing above
50 0 50 100 150 MILES
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES INVESTIGATIONS IN TEXAS, 1972 FISCAL YEAR
I D Yost, District Chief
300 East 8th Street, Austin, Texas
December 1971

UNIVERSITY OF ILLINOIS-URBANA
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